ZOOLOGY.—*The screw-nemas,* Ascarophis *van Beneden 1871; parasites of codfish, haddock and other fishes.*[1] N. A. Cobb, United States Department of Agriculture.

The *screw-nemas,* as it is here proposed to call them, have yet to be adequately studied. Not very much has been added to van Beneden's original description. Almost nothing is known about their life history and habits. However, the present communication adds considerably to our knowledge of their morphology. The suggested explanation of the remarkable screw form, and its probable mode of evolution, presents the nemic cuticle in a new rôle. (See Figs. 5, 6, and 7.)

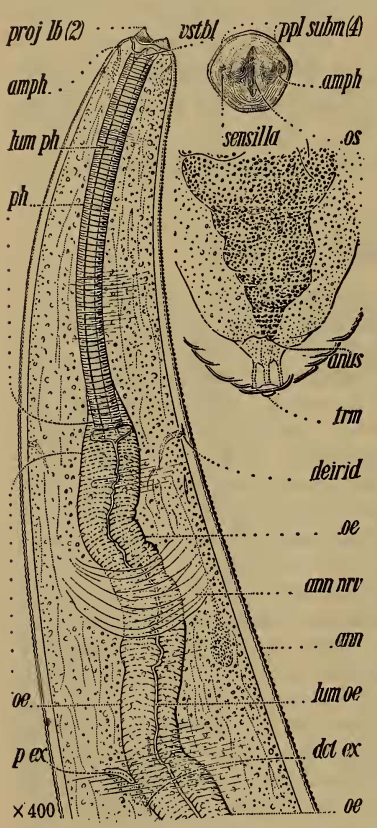

Fig. 1.—Head and tail end of *Ascarophis helix* n. sp. Above, to the right, front view of the lip region. The head end is nearly a ventral view, but slightly oblique. The tail end is a dorsal view, and the anus, being on the far side, is but indistinctly shown.

Considering the number of screw-nemas thus far seen, it is remarkable that *no males have been discovered.* Nicoll records screw-nemas as "extremely numerous" in haddock. Van Beneden found them originally in the codfish; Nicoll, in the codfish and haddock, and in the fishes *Hippoglossus vulgaris* and *Cotus bubalis;* and MacCallum now finds a species in the sting-ray.

Nemas so widespread and numerous *probably have economic significance.* This probability can not be dismissed by citing the absence of definite evidence to the contrary, for, at rather frequent intervals nowadays, nematologists are showing that nemas long known and lightly regarded, are not only of some importance in their relationship to mankind but sometimes of great importance; and the multitudinous ways in which this comes about may well give pause to any who, basing their views on past records and much current opinion, see in the presence of such parasites merely an interesting phenomenon.

[1] The investigations were carried on at the laboratory of the United States Bureau of Fisheries, at Woods Hole, Mass. Received January 3, 1928.

For example, it is now found that the presence of nemic parasites not infrequently has a profound effect upon the reproductive organs of the host, a limited number of the parasites even *producing complete sterility in a host otherwise apparently normal.* That such cases in their most definite form have thus far been found mainly in the invertebrate phyla does not invalidate the application of the idea to vertebrates, even were such cases wholly unknown in the vertebrata,—which they are not. Considering the well known universal specificity of certain chemical reagents,—chloroform for instance, a "universal" anaesthetic,—we should be prepared to accept without very much surprise some such universal specificity in the action of some hormones, particularly sexual hormones, whose origin traces back to *comparatively* simple, but fundamental, ancestral cell phenomena.

Again, there is abundant evidence of *high infant mortality* in a great variety of animals and plants, *due to nematism.* This, coupled with our ignorance of the early life histories and food habits of fishes, even common ones, makes it unwise to ignore the possible economic importance of the nemic parasites of fishes.

Many other examples could be cited of the multitudinous and unexpected ways in which nemas are being shown beneficial or injurious to mankind.

Ascarophis helix n. sp.

1.1 ..... 1.5 ..... 25. ..... 28 57. 44 ..... 99.8 ..13.2mm. The thick layers of the
0.6 0.7 0.8 1.2 0.2

transparent, colorless, naked *cuticle* are traversed by obvious plain transverse striae, which *vary markedly* in different portions of the body. On the head, however, the transverse striae are hard to resolve; yet critical examination of the striae immediately on and behind the lip region even resolves them into rows of dot-like elements. In this region the crenations of the contour seem duplex, four double crenations a short distance behind the head occupying 10 microns, so that each crenation encompasses about 1.25 microns. In the latitude of the nerve-ring the striae are 1.7 microns apart; thence backward they are gradually coarser and more distinct, each striation becoming a double line. Furthermore, it is soon apparent that the striations pass around the body in the *form of right-handed helices*—coarser and coarser, and more oblique, with increasing latitude, so that at the base of the long neck the coils are about 8 microns apart and lie at an angle of about 23° with a transverse plane. This obliquity increases until, near the middle of the body, it reaches a maximum of about 30° (Fig. 2). Thence onward, however, the obliquity diminishes. Somewhat behind the middle of the body, *certain coils of the helix fade*, so that the other, now more prominent, striae are as much as 20 microns apart, while their width is nearly two microns,—namely the distance apart of the double "lines" representing the striae. This "dropping out," or fading, of course, is evidence of the existence of a *plurality of helicoid "striae."* In this way the body of the nema takes

on the external form of an ordinary multiple-threaded screw. Here, in the middle, the contour of the body has become very coarsely and very pronouncedly *compound-crenate*. The more pronounced striae come to subtend twelve minor ones (Fig. 3). Finally near the tail end, the more pronounced striae subtend six minor ones (Fig. 3); this is near where the body is bluntly rounded off, in a hemispherical-conoid manner, in the course of a distance equal to about one and one-half body widths (Fig. 1). At first sight the deceptive appearance of the cuticle toward the posterior end of the nema *suggests moulting*, and consequent wrinkling of the cuticle. Longitudinal "striations," about 2 microns apart, due to the attachment of the musculature, are visible in most regions of the body. Posteriorly these longitudinal "striae" are still slightly oblique, and this slight obliquity extends practically to the terminus. There are no cuticular wings. With the nema in profile the lateral chords appear about one-seventh as wide as the body.

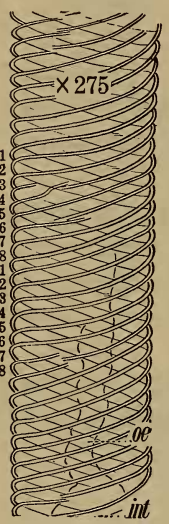

Fig. 2.—Camera lucida drawing of an oblique view of the eight-fold helicoid striae of *Ascarophis helix*, at lat. 23°, near the beginning of the intestine. The anastomosing occurs opposite the lateral chords.

The groove-like unarmed "vestibule" is very simple and shallow,—about as deep as the height of the two prominent, lateral, forward-pointing, conical *labial projections* (Fig. 1, *proj. lb.*). The vestibule leads through the slit-like mouth opening into a *long, uniform, tubular pharynx*, extending more than halfway to the nerve-ring. The pharynx is a *marked feature* of the front end, though it is so transparent and dimly refractive that it might, perhaps, under some circumstances, rather easily be overlooked (Fig. 1). Van Beneden seems to have figured the pharynx; Nicoll not, or at least not definitely. The mouth seems to lead into a minute pharyngeal or vestibular cavity, not very much wider than the amphids, perhaps six to eight microns wide,—a little longer dorso-ventrally than transversely. The median axil between the two lips is not sharp and distinct. The inner surfaces of the conical labial projections are not uniformly rounded and striated, like the outer surfaces,—for, near the middle, in their inner lateral lines or fields there are refractive longitudinal elements extending from the tips back to the mouth opening. It seems quite certain that there is an axial element extending to the apex of each of these conical projections, and when this is viewed in optical section, as one focuses from front to back, the appearances give rise to the opinion that there is a single innervation to each conical projection. One sees no evidence of radial musculature round the vestibule. There are no eyespots; and there is *no pigment* near the head, or elsewhere in the nema.

Returning now to the profile and dorsal views of the head;—four to five microns behind the tips of the two cephalic projections, exceedingly minute openings in the lateral region indicate the external amphids. As viewed *dorso-ventrally*, the anterior part of the walls of the pharynx, without diminishing much in thickness, *bend together* and nearly meet near the base of the vestibule, thus giving rise to the narrow mouth opening; in this anterior portion of the pharynx, the transverse striation is less apparent.

Behind the pharynx the *oesophagus* is a little less than one-third, at the nerve-ring about one-fourth, twice as far back as the nerve-ring a little less

than one-third, and then again soon—rather suddenly increasing—a little more than one-third, and finally is one-half, as wide as the corresponding portion of the neck. The lining of the oesophagus is a rather distinct feature throughout its length, and finds its main optical expression as a somewhat sinuous axial element. The musculature of the oesophagus is rather fine. Behind where the above-mentioned enlargement takes place there is a considerable amount of granular matter in the oesophageal tissues.

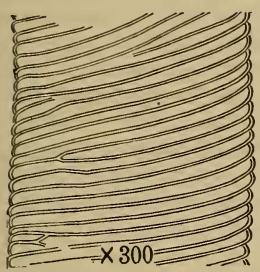

Fig. 3

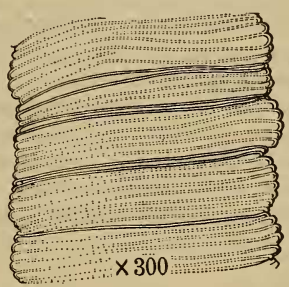

Fig. 4

Fig. 3.—Helicoid striae of *Ascarophis helix* considerably behind the middle of the body.

Fig. 4.—Camera lucida drawing of the contour of *Ascarophis helix* near the tail end of a female.

In front of this region the radial fibers are of a finer nature, closer together, and the granulation much less apparent, if present at all; in other words, there is a *distinct change in the structure of the eosophagus* at a point twice as far back as the nerve-ring. The intestine becomes almost at once two-thirds as wide as the body; it is separated from the oesophagus by a distinct cardiac collum somewhat less than half as wide as the body.

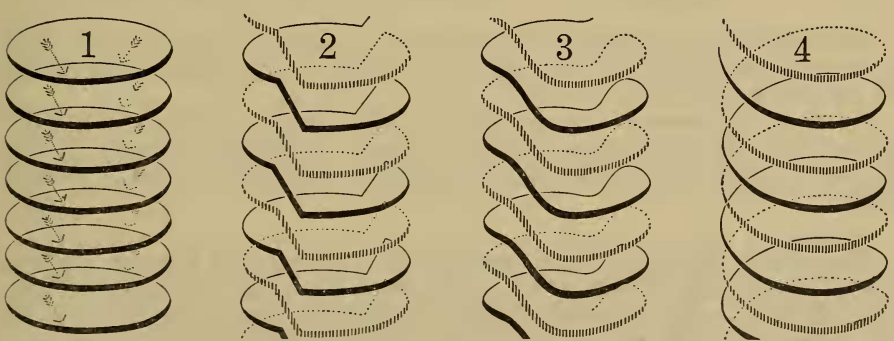

Fig. 5.—Diagrams illustrating a theory of the mode of origin of helicoid striae through anastomosing of the ordinary transverse striae of the nemic cuticle. Let 1 represent seven ordinary annules of a nemic cuticle, and suppose the anastomosing to take place on opposite sides of the nema at the places indicated by the arrows; 2 represents the anastomosing as having taken place, precisely as indicated by the arrows in 1; while 3 and 4 show the further theoretical transition to perfect helices. It will be observed that *two helices are formed*. Bilaterally symmetrical growth would necessarily lead to helices of *even* number, as exemplified in *Ascarophis*. See also Figs. 6 and 7.

The wall of the *intestine*, while not very thick, is somewhat irregular in thickness, the lumen appearing zigzag. At places the wall of the intestine is one-fourth as thick as the intestine is wide; at other places nearby its thickness may diminish by two-thirds. There is a distinct lining to the intestine, apparently made up of "columnar" elements vertical to the inner surface, though these have not been very clearly seen (Fig. 8). The granules contained in the intestinal cells are rather uniform in size, but their histological characters can not be made out on account of the state of preservation of the specimen. Well forward, near the blind end of the ovary, the intestine is not over one-third as wide as the body; and in this region the *body wall*, including the cuticle, occupies about one-fourth the radius, of which amount the vaguely retrorse cuticle occupies eight microns and the muscular tissue fifteen microns. There seems to be a *very short rectum*. The portion of the intestine just in front of the rectum is saccate, and, for a very short distance about half as wide as the corresponding part of the body; whereas in front of this enlargement the intestine is only about one-third as wide as the body.

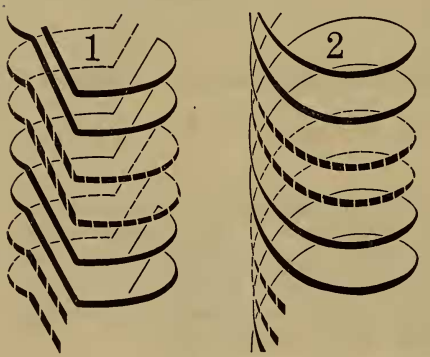

Fig. 6

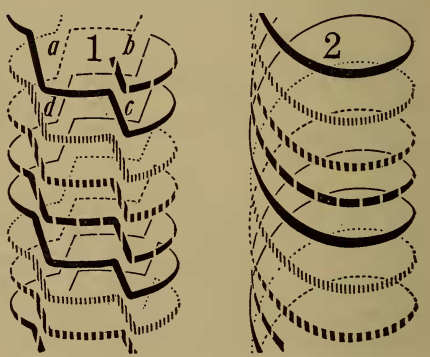

Fig. 7

Fig. 6.—Should two ordinary adjacent annules on each side of the nema behave as shown in 1, the result would be four helices; four such would originate eight helices. See also Fig. 7 and Fig. 5.

Fig. 7.—Should anastomosing take place simultaneously in successive annules opposite any four of the longitudinal chords *a*, *b*, *c* and *d*, say the four submedian, or the two lateral and the two median, the result would be eight helicoid striae. See also Fig. 6.

The blind end of the anterior *ovary*, about as wide as the distance between two of the adjacent oblique winds of the cuticular helix, is about two-thirds as far behind the cardia as this latter is behind the anterior extremity. In this region, in the body cavity, which is relatively of considerable capacity, there are *"floating" organs* made up of ellipsoidal or subspherical, fine granules, the largest of which are about eight microns in diameter (Fig. 8, *org fluit*). These "loose" organs are reminiscent of those known and figured in some of the ascarids,—e.g. *Ascaris kükenthalii*. The ovaries lie in elongate coils, and at first contain oöcytes about four microns across, which soon increase and become packed in the ovaries in the form of polyhedrons whose optical contour is often hexagonal, and which are 10 to 12 microns across where the ovary is one-third as wide as the body. The stretched-out ovary would be about

twenty times as long as the body of the nema is wide, and at its greatest width about one-third as wide as the nema. *Sperms* have not been seen, nor has the extent and nature of the oviduct been observed. The two *uteri* are filled with six to eight hundred ellipsoidal *eggs* about one-third as long as the body is wide and averaging 40 × 24 microns. For a short distance near their equator the eggs are practically cylindrical. The shells are thick—a little over 2 microns—and structureless looking; are of uniform thickness throughout; and, as seen in the uteri, are *without any surface markings or appendages*. No indications were seen of "two flagellae at one pole," as noted by van Beneden and Nicoll. It is possible that appendages might arise later, e.g. from some vaginal secretion coagulated during deposition. The eggs, before deposition, contain fairly well developed *larvae*. There is a *single ovijector* of considerable length passing inward from the vulva; apparently the ovijector is several times as long as the body is wide; —say at least three times. Its walls are thick and muscular; viewed in optical section it is nearly one-third as wide as the body, being somewhat flattened when collapsed, and so, in cross-section, a little more than half as wide as long. Its lining is thin and strongly refractive; the wall, when seen in optical section, is glassy internally and fibrous externally. The *vulva* is a transverse ellipsoidal affair near the middle of the body, about one-fifth as wide as the corresponding portion of the body and interrupting two to three of the spirals. It is about twice as wide as long, is distinctly marked, and presents a double refractive contour, especially posteriorly. The excretory pore is an opening of considerable size, taking up the space of about three annules of the cuticle. For a short distance the tube is strongly refractive, then suddenly becomes almost invisible. In the specimen under examination it is impossible to follow it far enough to say whether in its course it becomes double and symmetrical or remains single and asymmetrical (Fig. 1, *p ex.*)

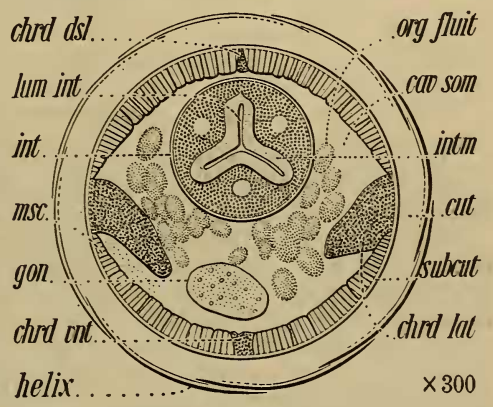

Fig. 8.—Somewhat schematized drawing of a cross-section of *Ascarophis helix*, taken not far behind the neck. Eight helices are cut, as at *helix*.

Diagnosis: *Ascarophis* having a length of 13 mm.; striae helicoid, the sub-cephalic ones very fine and not retrorse, the posterior ones very coarse and compound, their maximum obliquity,—behind the nerve-ring,—30°; the two labial projections broadly conoid; pharynx tubular, 1.1%; tail convex, and rather symmetrically short-conoid, 0.2%; eggs without polar filaments.

Habitat: Gills of the fish, *Dasyatis centrura*, sting-ray. This unusually interesting nema was discovered by my friend, Dr. G. A. MacCallum, at Woods Hole, Mass., August, 1927, while examining material collected by the Bureau of Fisheries. Hitherto members of the genus *Ascarophis* have been found only in the intestinal canal of fishes. Previously the species have been but very imperfectly described; males have not even been mentioned. The helicoid development of the outer cuticle is especially in-

teresting. No other nemas known to me present this feature. I can only suggest that a plurality of helices has *evolved through anastomosis* such as has been frequently seen, and often figured, in cases where the annules of the nemic cuticle are a marked feature; this anastomosis, if increased in extent and systematized as shown in the diagrams (Figs. 5, 6 and 7) could give rise to helical striae. The anastomoses in *A. helix*, as far as seen, are lateral.

The facts recorded in this communication regarding the helicoid striae, and the theory of the method of their formation accord with the writer's observations (1888[2]), that the longitudinal chords are a seat of the formation of the fibrous cuticle in nemas.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

964TH MEETING

The 964th meeting was held at the Cosmos Club November 26, 1927.

Program: The evening was given to reports from the Prague Meeting of the International Geodetic and Geophysical Union.

WILLIAM BOWIE: *International coöperation.* There are very few branches of science on which international coöperation and conferences are not desirable. One of the branches which needed such coöperation very early is geodesy. About 65 years ago the geodetic association having representation from the states of the German confederation was enlarged to include all of the countries of Europe. Then, about 1886, the European Geodetic Association was enlarged to the International Geodetic Association, taking in all of those countries of the world in which geodesy was active and which cared to join.

Then there were the Seismological Association and the Astronomical Society. Besides the societies for Meteorology and Terrestrial Magnetism, there were the Geological Congress and the Geographical Congress. It would be rather difficult to estimate the number of international scientific associations that were in existence prior to the world war but, in any event, the government of the United States paid dues to seven of them. The others were not considered as being of an official nature and therefore do not appear in the list of those receiving government support.

All of those old associations and societies did notable work. They advanced greatly the various sciences involved and the periodical conferences or conventions made it possible for the workers in any one field to get together and become personally acquainted.

It has frequently been said that very little is accomplished at such conferences. I am rather inclined to differ with this view. The reports of the proceedings may indicate that nothing very definite had been accomplished by the delegates and committees in their general meetings, but the many conferences of the delegates in their rooms and in hotel lobbies and while

[2] Beiträge zur Anatomie und Ontogonie der Nematodon. Gustav Fischer, Jena, 1888.